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No. 729

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CONTENTS

STUDIES OF NUCLEAR PHYSICS INSTITUTE AID ECONOMY

Tirana ZERI I POPULLIT in Albanian 19 Dec 81 p 3

["Studies Which Help To Increase Production and To Improve Its Quality"]

[Excerpts] The scientific-research activity of the Institute of Nuclear Physics, guided by the teachings of Comrade Enver, its director Skender Koja told us, has been developed in directions which are of special interest to our economy and our life.

Among the many projects completed in 1981, the following are worthy of note: the study which has been made in connection with the soil in Lushnje (in Krutje), a study which is included in the multi-year theme "Nuclear methods in the solution of problems related to the rational use of fertilizers." The recommendations made in this study will be forwarded to the appropriate department for execution. The application of the recommendations will result in a considerable saving in phosphate fertilizers for the agricultural units.

In its scientific research activity, the institute is also concerned with the designing and construction of a prototype of automatic control apparatuses for industrial needs. This year, a number of industrial items which are very much needed by our light industry have been constructed and put into use this year. Also, the construction of meters at the fluid level in various reservoirs has been of special interest for industry. Seeing the effectiveness of this apparatus, the institute has received requests from various sectors of production to direct the series production of such apparatuses by our electronics industry. This year, preparations have been made to put into operation, in the future, a device for the continuing automatic measurement of the density of the rinsing solution in oil wells.

In light of the importance of geochemical methods in prospecting for and discovering petroleum and other ores, the collective of the institute is using two modern methods of analysis more successfully--neutron activation and fluorescent X-ray. In order to take care of the large number of analyses which are required by the basic units (thousands of such analyses are carried out in the institute) a service group, composed of physicists, laboratory workers and skilled technicians who make analyses for the petroleum and geology sector, has been set up. These people give exact determinations of the presence of traces of elements in small quantities in the soil, and the location of layers of oil-bearing ores or

other ores. The advantages of these methods, compared to earlier methods are, first of all, the speed of the analyses and their accuracy and the identification of some elements which other methods do not discover.

During the past year there have been other studies of great interest to the economy such as the studies aiming at the extending of the period which some agricultural crops, especially potatoes and onions, can be kept and the stimulation of seeds to increase productivity without supplementary investments.

It is important to stress that the results achieved here over many years conform to those achieved by scientific research institutions in other countries. Therefore it is time for the studies concluded in these fields to be accepted immediately and without hesitation by the ministries concerned and put into practice.

A very important aspect of the activity of this institute for this year is the study of the production of radiated polyethylene, which has new insulating properties in the most difficult situations of corrosion and humidity. On the basis of such a study, polyethylene has been produced for some large electrical units of the "V. I. Lenin" hydroelectric power plant, the metallurgical plant and other factories. The communications sector has also requested this product.

Additional elements in ore samples will be identified in 1982. Also, the assistance which the institute gives to the petroleum sector will be expanded, both in the field of research and in the field of rational utilization of wells.

CSO: 2102/4

CSSR'S SHARE IN INTERKOSMOS SPACE COMMUNICATIONS PROGRAM

Prague TELEKOMUNIKACE in Czech No 10, Oct 81 pp 147-148

[Article by Svetozar Durovic, Communications Research Institute, Prague]

[Text] The wideranging scientific and technological development program known by the acronym INTERKOSMOS is subdivided into five subject areas--space physics, space meteorology, space communications, space biology and medicine, and remote-sensing earth sciences research. The Ministry of Communications has jurisdiction over problems associated with space communications.

The Standing Task Force for Space Communications, which is in charge of directing programs of common concern, has identified some primary areas of interest (subject areas is the usual term of reference) and subdivided them into eight research topics:

IK 1 -- The development of new frequency wave bands, research into the design of space satellite communication systems operating in the 10-30 GHz wave bands;

IK 2 -- Research into optimal methods for the transmission of signals in satellite networks in conjunction with the application of advanced technologies;

IK 3 -- Research into the principles of interacting satellite and ground-based communications systems;

IK 4 -- Monitoring issues affecting the development and optimilization of the construction of ground station systems for satellite communications;

IK 5 -- Research into the principles of the effective application of geostationary orbits and shared frequencies of satellite and ground-based systems;

IK 6 -- Research into Satellite television transmission systems operating in the 12 GHz wave band and planning for their introduction into service on an experimental basis;

IK 7 -- Research into multilateral access methods;

IK 8 -- Uncooled low-noise parametric amplifiers operating in the 3.7-4.2 GHz wave bands.

Czechoslovakia is making a contribution to solving problems in virtually all of these research topic areas, but it is devoting special attention to the tasks mandated under the terms if IK programs 1, 2, 5, 6, and 7.

At the present time the IK-1 research topic is being pursued as a part of work on the construction of the international experimental testing center in Dubna (USSR). The focus of attention there is on the installation of equipment, and individual member countries will have an opportunity to carry on appropriate scientific-technological research programs. Special signals will be sent out from this research center to satellites which in turn will make it possible to bounce these signals back to the national testing centers of the member countries.

The design of the experimental satellite system operating in the 11-14 GHz wave band was coordinated by the GDR, and this design in turn served as the source of the standards that were applied in the development and production of the essential systems that were used to equip the testing centers. The main contributors to the development of this technology are the USSR (first-generation receivers and transmitters and second-generation transmitters), the GDR (computer hardware for the testing centers used to evaluate the experimental signals and to further enhance them), and the CSSR (second-generation receivers and radiometers for the 12 GHz wave band). Other countries played a part in this experiment by contributing auxiliary systems such as rain gauges, registers, and so on.

The birth of the first Czechoslovak receivers for the 12 GHz wave band was not an easy one. In connection with the design of the experimental IK-1 system the CSSR was charged with coming up with a design for a fully equipped second-generation set, i.e., a transmitter and a receiver equipped with a small antenna with a diameter of 3-4 meters, a power output rating of 250 watts, and a receiver quality rating of 20 dB/K. This system was designed for the duplex transmission of smaller-scale digitalized telephone signals, wide band television reception, and the reception and evaluation of signals for purposes of signal propagation research. Unfortunately, the Czechoslovak electronics industry was not able to meet demands for the development and manufacture of a complete set, in particular for reasons having to do with problems connected with the output travelling-wave tube for the 14-GHz wave band. Consequently, there was nothing left to do but scale down the demands that were originally levied upon the industry and focus solely on the development of the receiver portion of the system. On the basis of technical specifications worked out in conformity with a system design produced by the Communications Research Institute the Communications Technology Research Institute, working together with the Radio and Electronics Engineering Institute of the Czechoslovak Academy of Sciences (which designed a local oscillator set with an extremely high frequency stability rating), developed a second-generation receiver and delivered the finished product to the contracting agency. In many important respects performance standards were achieved that surpassed those required under the terms of the original order.

Staff members of the Communications Research Institute put together a radioelectrical part for a new standardized housing which rendered the receiver unit transportable with much more room for working parts and a much enhanced capability for resisting atmospheric influences. The set was supplemented by the addition of a limited high-gain antenna system which further enhances the usefulness of the

entire component. The system was then subjected to exhaustive tests and checked out under long-term operational conditions. In May 1981 it was sent to an international testing center in the USSR. Here too it gave a good account of its performance standards and, with this successful design record to its credit, it was well received among Interkosmos users.

However, the CSSR was not yet completely finished with its work on the research and development of a second-generation duplex set. After lengthy negotiations between the Communications Research Institute and the Communications Technology Research Institute success was finally achieved in coming up with a design for the second component of this set which makes it possible to link up the receiver with a transmitter that was developed elsewhere. In addition to this capability, the set has a bigger antenna with a diameter of 4 meters that can operate throughout the entire spectrum of from 11 to 14 GHz.

Work is proceeding at the same time on the construction of our own national testing center. This construction work is now under way at the site of the Sedlec radiocommunications center which, in spite of its rather modest endowment of equipment, has everything that is needed for this kind of experimental program. In addition to space communications sytems, work is also moving ahead here on the installation of sections of ground lines for research into the propagation of frequencies in excess of 10 GHz as well as on the installation of radiometric monitoring systems.

The CSSR has been very actively involved in working on research problems mandated under the terms of the IK-2 program, and this is a consequence of the unprecedented interest that exists in this country in new modulation methods for transmission purposes. Three outside laboratories have applied to participate in this research program.

The Electrical Engineering Faculty of CVUT [expansion unknown] is working on research into digital television transmissions via satellite communications networks. It goes without saying that the overall problem of digital television cannot be addressed by any one research project. This project is devoted only to working out some of the problems at hand, namely, research into adaptive delta modulation combined with composite coding and, further, time multiplex digital television combined with other data signals, something which would open the way for a larger scale transmission system for subscribers to satellite communications traffic. Inasmuch as the designers want to exploit the 27 MHz wave band for the transmission of an integrated signal, this suggests that this capability will be applied some day within the framework of a system used for the direct broadcast of television and radio programs via satellite.

The Radio and Electronic Engineering Institute of the Czechoslovak Academy of Sciences is conducting work in the area of digital phased modulation and it has produced a model capable of a transmission rate of 20 Mbit/second. The receiver employs coherent detection, whereby the regeneration of the coherent carrier is assured by means of remodulation and filtration through a phased carrier and the timing frequency is derived by means of a crystal filter.

At the Tesla Communications Technology Research Institute work has been successfully completed on the development of a system for the transmission of multiple

audio signals which are integrated into a television carrier signal. This principle consists of the application of PCM [pulse coded modulation] to audio signals and also in the time-multiplexing of digitalized audio signals over a television transmission path. Over the course of prolonged tests conducted in the CSSR using ground and satellite communications networks it has been demonstrated that the transmitted signals are of high quality (according to one option two discrete radio channels can be transmitted over a television signal with a "Q" quality rating) and that the system has a significant performance capacity rating. The virtue of this performance rating consists in particular in the fact that it is possible by a simple selection process to change operating transmission modes and, wherever necessary, to transmit up to eight commentator signals with a "B" quality rating. This is a very effective tool that can be used by both programming employees and communications technicians, since it is now possible to choose an operating mode option that best fits the requirements of the situation at hand. The principles according to which this system was developed have a number of other applications (the transmission of several audio signals in a television broadcast, high-quality sound in systems employing the direct propagation of television signals via satellite, and many others).

The CSSR has already submitted reports to INTERKOSMOS experts on the results of these tests. This system has also attracted a great deal of interest due to the fact that within the context of the programs of international scientific experiments that are being conducted under the terms of the IK-2 project this system will be tested both in the conventional 4/6 GHz wave bands of satellite communications systems and in the new 11/14 GHz wave bands at the international testing center in the USSR.

The CSSR is coordinating the IK-5 research program. Our principal contribution to this program consists in the development of frequency planning methods using computers. This is an entirely new discipline, which, in addition to figuring out the radio-electrical principles of systems compatability, must also solve problems related to the integration of this system with computer technology, including data classification, the efficient utilization of this data, and so on.

The first experimental groundwork for this new perspective on this problem was the frequency plan for a satellite broadcast service operating in the 12 GHz wave band that was worked out as part of preparations for the WARC-BS-12 GHz World Conference. A joint coordinating process, in which the CSSR and the USSR were the main contributors, resulted in the formulation of a draft plan that was adopted by government organizations of the socialist countries as the basis for the positions presented by our countries at this conference held in 1977. This plan made it possible to conduct working spotchecks while the conference was in progress and contributed to the successful outcome of the negotiations, meaning that all of the demands advanced by the socialist countries with respect to frequencies and orbital positions for a satellite broadcasting service were accepted.

Based on the experience that was gained in connection with the application of these interdisciplinary approaches, planning methods are now being worked out that are applicable not only to putting entirely new systems into service, but also to the modification of wave bands already in service in support of the fast growing

network of ground-based and satellite systems. This is an exceptionally important task, since adaptive methods are capable of respecting existing systems, without hampering the development of new systems.

The IK-6 research program has now become a topic of prime concern. The fully loaded frequency wave bands of the ground-based television transmission system make it impossible for us to introduce even a third television program channel in this country that would have nationwide coverage. The satellite broadcasting service systems that are slated to go into operation in neighboring western countries are a sufficiently important challenge to engage in competition in this field as well. And, finally, it is necessary to take into account worldwide trends which indicate that television transmission wave bands at the lower end of the frequency spectrum are being opened up for the use of mobile services.

The whole problem area of line-of-sight electromagnetic wave propagation is subdivided into a systems component and a frequency plan component. As a part of a jointly coordinated effort on the part of the countries concerned plans are being made for standardized systems and transmission parameters for a new service. These parameters will then lay the groundwork for the development of the engineering specifications that will be applied to the system's ground-based and space-based sectors. At an international scientific symposium held in Warsaw in 1980 the CSSR presented its contribution toward solving this problem. A study that is to be made of the positions presented by the respective countries concerned is supposed to culminate in a plan for an international experimental satellite broadcast service system which would enable the member countries to use their shared television satellites to test the system's engineering and technological features. The CSSR has announced that it is ready to participate in this cooperative venture, and, in view of the timeliness of this service as far as our own country's needs are concerned, is devoting increased attention to this program.

The CSSR is working on the IK-7 research program by way of the MODIKA computer simulation program--a model of a digital channel which is paving the way for the introduction of digital transmissions via satellite channels. This simulation project involves the modeling of all of the important components of the transmission path (receiving and transmission filters, nonlinear elements in the transmission path, and so on) as well as other factors having an impact on the system (Gaussian noise, interference). This program makes it possible to set up for almost any modulation method of signal degradation. This channel model was developed by the Communications Research Institute with respect to the frequency aspects of the problem and by the Radio and Electronic Engineering Institute of the Czechoslovak Academy of Sciences with respect to problems having to do with the time representation of signals. Both institutions, however, are providing full range of information concerning the transmission of a digital signal via a ground-based or satellite-based channel.

Czechoslovakia is making a contribution to almost all of the space communications research projects covered by the INTERKOSMOS programs. It is a noteworthy fact that Czechoslovak industry is playing a role in the fulfillment of some exacting job orders. This is going a long way toward enhancing the value of our contribution to this common task, since this opens the way for the follow-on production of actual systems, first for experimental purposes and later on for normal operational purposes. By virtue of its combined scientific, research, and development contributions to INTERKOSMOS programs the CSSR is furnishing documentary proof of the importance which it attaches to joint ventures.

11813
CSO: 2402/7

LONG-TERM GOALS OF ELECTRICAL INDUSTRY OUTLINED

Prague JEMNA MECHANIKA A OPTIKA in Czech No 10, Oct 81 pp 257-259

[Text] In the preceding article dealing with long-term development of the machine industry we pointed out principles that the machine industry as a whole, and essentially also its microstructure, must use as a guide in its long-term development. Now we should examine what specifically ought to be the structure and microstructure in which the entire machine industry should develop. We start out with the premise that we and, understandably, not only we, singled out the utterly inadequate development of the electrical and, particularly, electronic industry and, within the latter, a considerable lag in a modern parts base, as the basic imbalance in the macrostructure of the entire machine industry. For that reason we shall deal in this article with the possibilities for potential elimination, or at least considerable alleviation, of this lag.

Innovations in electrical engineering and, particularly, in electronics are one of the decisive trends in scientific and technical revolution. They affect in an extraordinary way the national economy, the country's defensive capabilities, all scientific disciplines, medicine, culture, standard of living and the life style of a citizen.

Products of the electrical industry, particularly in the area of electronics and microelectronics, by themselves, or as components of products of other sectors, increase the social productivity of labor and add a new dimension of quality to mental work. They call for new professions, change the style of work, increase demands on theoretical knowledge. At the same time, they eliminate some formerly indispensable jobs. According to some prognoses, the absolute reduction in the number of workers in traditional occupations due to automation and computer technology should reach 50 percent by the year 1990, which will call for basic changes in the structure of professions. Under conditions of a capitalistic society such changes causes unemployment and intensification of class conflicts while, on the other hand, under conditions of a socialist society, they effectively promote implementation of the political objectives of socialism.

Decisions regarding the concept of further development of electrical engineering branches will have to respect their specific characteristics:

--they are existentially connected with the development of scientific disciplines--physics, chemistry and others;
--their innovation cycle is becoming increasingly shorter (e.g., in the case of microprocessors it is now 3 to 5 years), which calls for a much faster rate of

substitution of technological equipment than is the case in traditional mechanical engineering branches;
—the branch of electronics in general and that of microelectronics in particular poses little demand on conventional materials, energy and transportation, but requires smaller amounts of special and precious materials and semifinished products;
--the level of electronics, automation and computer technology has a decisive effect on the effectiveness of weapons systems and growth of the combat capability of contemporary armies and, in consequence, development of specialized electronics receives extraordinary attention of governments, with an embargo imposed on a number of sophisticated products and systems;
--electronics on world markets is characterized by high prices per kilogram of substance;
--the utility value of its products is increasing fast, even with the current decreases in production costs and prices, which are particularly pronounced in microelectronics;
--effectiveness of electrotechnical products from the viewpoint of the national economy must be assessed comprehensively—to include all generated savings and increases in prices per kilogram of final products and systems, as well as all savings accruing to their users.

There is a close relation between electronic consumption and the economic level of countries. For example, in the countries of Western Europe consumption of electronics represents approximately 2 to 2.5 percent of the gross national product. A rough comparison indicates that consumption of electronics in the CSSR is still only about half of what would be commensurate to the level of its national economy.

Yet, it cannot be claimed that we did not pay full attention to this sector of the machining industry until now. Already in the 3d, 4th and 5-year plans priority was given to the development of new branches of electronics and semiconductor technology. A number of accomplishments were achieved in comprehensive mechanization and automation, proficiency was gained in production of machine tools with modern controls, to include automated processing lines, of electron microscopes, television sets, etc.

In the Fifth Five-Year Plan development of light current engineering formed a part of the so-called developmental support program envisioning a triple increase of production in the course of 5 years. The directive for the Sixth Five-Year Plan also very specifically pointed out the need for priority development of the electronic industry and stipulated:

--continued development of light-current and electronic systems and implementation of expedient development of a parts base for electronics with priority given to microelectronic circuits with a high degree of integration and striving to attain a high technical level of machinery by stepping up...miniaturization of electronics;
—in the area of complementary products provide for development and production of measurement, regulation and control equipment, cables...;
—increase the share of automated machinery sets and lines and in production step up the share of numerically controlled machinery;

--orientate natural, technical and economic sciences on... development of electronics, automation and optimization of process control in complex, primarily technological systems.

These are without a doubt proper directives and their implementation also was not bad. On the basis of original development and by means of licensing arrangements came the development and, as of 1980, introduction into production, of new series of microelectronic components, i.e., numerical and analog integrated circuits with a high degree of integration. On the basis of international cooperation came the development of new systems of computers, computer EC 1025 for mass data processing and minicomputers SM 3-20 and SM 4-20 for control of production processes, together with their peripheral equipment, i.e., printers, memories, etc and software. Production started on new drive units for MEZOMATIC feed mechanisms which facilitate numerical control of machine tools and replace gearboxes with labor-intensive gearing. Basic research solved a number of tasks to meet the needs of electronics and microelectronics, such as development of an electron lithograph which facilitates exposure of submicronic structures, i.e., up to a million elements in a single integrated circuit, research of optical communications, etc.

Thus, the problem is not constituted essentially by any failure to comply with directives but, rather, by underestimating the growth of demand and a complete misinterpretation of the position occupied by the electronic industry in the overall system of the national economy. After all, innovations in electrotechnical engineering, and particularly in electronics, are one of the decisive trends in technoscientific revolution. They are of strategic importance to the national economy and are an integral part of policy of governments. In one of the previous articles we pointed out the amount of attention devoted to this field by the Japanese government which considers it to be the basic strategic element in the development of the national economy as a whole.

We too must draw appropriate conclusions from these facts. And that was actually done. The 16th CPCZ Congress adopted the following resolution in regards to this problem:

The problem of prime importance is development of electronics and microelectronics. We envision establishing their lead ahead of other mechanical engineering sectors, because we are aware of the fact that systematic electronization and automation applied to key sectors brings about considerable improvements in social productivity of labor, reduced consumption of raw materials, fuels and energy. To that end, in the coming years we must gain mastery in the production of integrated circuits for microprocessor technology, particularly memories, processors, test circuits, optoelectronic communication systems and investment electronics.

In the current period we are preparing a long-term program for development of electronics which is to encompass solutions to basic problems of this field in research, in international cooperation, particularly with socialist countries and the USSR, intensification of production capacities, as well as a program for introduction of electronics into individual sectors of the national economy. This line applies to the Seventh and Eighth Five-Year Plans. Contrary to other branches of mechanical engineering, the long-term outlook in electrical industry

will be dealt with specifically for shorter terms than the year 2000. The reason for this is the fact that substitutions in products assortment in this industry and innovation cycles are so short that a specific outlook to the year 2000 would be very inaccurate if not downright impossible. After all, who could have envisioned in 1960 that in 1980 application of microprocessors would occur at an industrial scale, that there would already be robots of the second and third generation in operation, that first transmissions would be made by means of opto-electronic communication systems, that videotelephones and videorecorders would be routinely used worldwide and that television sets would become household movie houses of a sort, with random selection of programs, a means of individual entertainment and source of information, etc. The rate of innovations of this type can and probably will be even faster and more surprising in the next 20 years than it was in the past 20 years.

If we take a closer look at the distribution of electric industry production, we find that almost 50 percent is supplied by this industry in the form of complementary products for final machine production, approximately one-tenth accrues to deliveries for investment, approximately 15 percent go for exports and only about 6 percent go to meet retail demands. A significant item in deliveries for investment is formed by metrological, automation and computer technology.

Deliveries for consumer goods inventories in the Seventh Five-Year Plan will be increased 37 percent (in retail prices) in comparison to the Sixth Five-Year Plan. The plan includes a significant increase in the production of color TV sets with the most modern screen produced under license, there will also be increases, e.g. in deliveries of tape recorders, record players and radio receivers, wherein already at the present the CSSR has an exceptionally high rate of availability in households. With increased deliveries of products for long-term personal consumption, it is envisioned to improve their technical level, attractive design, improved operational reliability and relative decreases in power input.

The plan calls for increased rates of exports to socialist countries. Substantial increases are planned, particularly for products of heavy-current engineering, metrology, control and medical instrumentation. The volume of exports to nonsocialist countries will be constituted primarily by deliveries of heavy-current engineering systems including assemblies, electric motors, metrological and control systems as well as color picture tubes produced under license. It is expected that exportation of medical instrumentation, which has been a very effective export item, will continue.

In comparison to direct exports, indirect exports have been substantially higher as part of exportation of complete industrial plants, complex systems and machinery products.

Let us point up some specific examples in regards to innovations in electronic production in the next period. Investment electronics constitutes roughly one-tenth of electronic production volume. A new series of television transmitters for the fourth television band (for the second television program) uses transistors for its future stages and for its output stages it uses also modern elements, the so-called clystrons of Czechoslovak production. A follow up to the transmitters is a transistorized series of television converters for the fourth and fifth TV bands designed for color transmission. For deliveries to the USSR was

completed a new type of ZONA 2 television transmitter with transistors, switching semiconductor circuits and Czechoslovak power tubes. Further expansion of color television in the CSSR will be promoted also by gaining proficiency in the production of equipment for studio use, to include new Czechoslovak movie cameras that already constitute the equipment of some studia.

A contribution to expanding the extent of long-distance transmission and telephone paths will be made by a new radio relay system for 300 channels with a frequency-division telephone multiplex and a modern radio relay system with 30 telephone circuits with pulse-code modulation. This innovative step is characterized by full transistorization and a high degree of automated operation. Development of the sector of telecommunications will also be enhanced by the results obtained in development of the second generation of telephone exchanges with crossbar switches and predominantly relay control.

Of key importance is the sector of computer technology where personnel engaged in development completed a number of tasks relevant primarily to utilization of integrated circuits. This involves a set of basic and peripheral units for RPP 16 Standard and Mini control computers and JRP 12 minicomputers as well as completed development of an integrated version of a computer for mass processing of data, the TESLA 300, also with additional peripheral equipment (magnetic tape memory, control units, etc). Development of electronic calculators focused on types with integrated circuits of high density.

In the area of numerical control of machine tools, a number of control systems of the third generation was implemented. Developmental efforts were concentrated on design of control elements for electric servodrives, systems controlled by minicomputer, adaptive systems and units for high-precision position measurement. Potential applications of numerical control point also toward the area of automatic handling equipment, robots, and others.

To provide a wider view of innovative efforts in the sectors of investment electronics it would be possible to also mention sets of systems for data transmission, a system of radio stations with random selection of subscriber in the radiotelephone network, radar equipment, instrumentation from the area of measurement of electric parameters and spectrometers of nuclear magnetic resonance as well as instruments for measurement and detection of nuclear radiation, etc.

Deserving of attention is also the relatively young sector of electronics for medicine. This involves primarily instruments for diagnostics, monitoring sets and instruments for stimulating the function of human organs (such as a series of radiostimulators).

Another group of products is constituted by consumer electronics the assortment and innovation of which are in keeping with the development of technology and services. For example, in the area of sound reproduction the new technology must interface with the shift from mono to stereo and, in the near future, with quadraphonic reproduction. Similarly, in the case of television, from black-and-white image to color and ultimately stereo television. Thus, a new trend for innovation is also other instrumentation for recording and reproduction of quadraphonic signals and in the stage of developmental studies is instrumentation for recording of images, primarily videorecorders and magnetoscopes.

The common technical characteristics of contemporary radio receivers are fully transistorized design, gradual introduction of integrated circuits, concentration of selectivity, electronic tuning and sensor control in case of the more demanding types.

The production program for television receivers went in 1975 through a basic innovation stage formed by a switch to the modular concept of the chassis of black-and-white and color television receivers. This step is to facilitate a technically and economically gradual shift from hybrid types of receivers to an entirely semiconductor base. This concept will at the same time improve the technological process of production, particularly by facilitating optimum utilization of testing and control systems for automation purposes.

An adapter for replay of quadraphonic records is also ready this year for stereo record player chassis 130 and 140. At the same time provisions are being made for production of quadraphonic record players with a four-channel amplifier.

The stage of monophonic types in the area of reel-type tape recorders is coming to a close. For the coming period the B 73 stereophonic four-track tape recorder with three heads is ready and the B 83 new hi-fi tape recorder is envisioned for the future. In providing cassette-type tape recorders, attention is concentrated on international cooperation with the Hungarian People's Republic, the first result of which is, for example, a combination of a stereo record player, an amplifier and a stereophonic tape recorder.

The plan for technological development must play its role in improving the level of innovations, so as to promote the effects of technical and economic tools on a more expedient implementation of scientific and technical advances in practice. It is obvious that the extent of sectors of electronics that pervade all areas of social life cannot be provided solely by domestic capacities. For that reason a widely based division of labor has been organized in a number of sectors, particularly within the framework of CEMA, so that coordinated production programs of socialist countries would supplement the market byproducts and goods according to the comprehensive needs of users. In addition to providing investment electronic products for industrial sectors, attention will have to be paid also to the growing demand for electronic consumer goods, their higher quality, technical parameters, the level of utilitarian properties and esthetic appearance.

In supporting exports and deepening the international division of labor it will be necessary to overcome some limitations that are specifically characteristic of the branch of electrotechnical engineering:

--products of certain sectors place high demands on materials in short supply (nonferrous and precious metals, plastics, special materials). These include, e.g., transformers, electric motors, cables, batteries, etc. Therefore we see in individual socialist countries the manifestation of tendencies against exporting such products, or at least an effort to balance exports and imports, because it is these products that are in short supply in those countries as well;
--in the case of consumer electronics and electrotechnical engineering some products gradually saturate the domestic market by a traditional assortment of products and the individual country decidedly prefer their own production to imports.

In the subsequent period it will become necessary to rely on results of technological development which will constitute the production of the future.

This development will be oriented toward:

--implementing the technology of integrated circuits of high complexity;
--designing complex unipolar circuits for a 16-bit microcomputer system;
--developing optoelectronic elements and bubble memories;
--developing an electronic lithograph;
--developing processing methods using ultrasound, electroerosion, laser;
--electron microscopy and spectrometry;
--developing instrumentation for gas and liquid chromatography and pulse electrochemistry;
--new types of scintillation and gas detectors;
--new radiolocation systems;
--radio and television transmitters, radio stations and radio networks;
--developing communication systems with light-guidance cables;
--completing EC 1027 systems, problem-oriented peripheral subsystems;
--large-capacity disk memory;
--a system for automated design;
--developing cassette and elastic disks;
--a new microcomputer system;
--application of microelectronics and microprocessor technology;
--special servomotors, stepping motors;
--color television sets with "inline" picture tubes;
--stereophonic cassette tape recorders;
--innovation of record players of medium and upper class, new sources of light, chemical sources of current;
--new instrumentation for medical technology.

8204
CSO: 2402/9

PROPANE-BUTANE ADAPTER SAVES GASOLINE

Prague SVOBODNE SLOVO in Czech 28 Nov 81 p 14

[Text] Experts all over the world are currently endeavoring to replace the traditional fuel for motor vehicles--gasoline or diesel oil--by other sources of energy. A very interesting contribution to this effort represents the research of a team of efficiency promoters from the Highway Transportation Center in Plant 7 of the industrial concern Vitkovice--Iron Works and Engineering Plants of Klement Gottwald [VZKG]. The team headed by D. Horecky built and tested its own system--a propane-butane gas adapter for routinely produced four-stroke spark-ignition engines.

The five-man team began to develop the device in VZKG in 1975 as part of an effort to economize automotive transportation and improve the environment throughout the plant--in addition to their routine duties. While similar systems are designed abroad for liquid gas, in Vitkovice they came up with their own original solution: gaseous propane-butane.

The principle of the system consists in feeding propane-butane to a pressure reducing valve in gaseous state and from there into the main fuel system of the engine. It also makes use of a circuit for preheating the propane-butane charge to promote utilization of the entire contents of the pressure bottle. Its control and safety system is automated by means of semiconductor technology, whereby preparation of the propellant mixture itself is taken care of by a pressure reducing valve of their own design. The original system received the designation AP-VB-1 and, after some improvements, it became the updated AP-VB-2.

The new system does not interfere in any way with the function or structural design of a conventional gasoline engine and its fuel circuit. The vehicle can be driven independently by gasoline as well as by propane-butane, meaning that the type of fuel can be switched, even during operation, just by flipping a switch on the dashboard. Thus, the gasoline engine remains in its original state, only a gas jet is attached to the carburetor. The authors of the system cannot mention and analyze further technical details; it involves a Czechoslovak patent protected by an authorship certificate.

Tests of the new system were carried out recently in the Testing Institute for Engineering, State Testing Center 202 in Brno. Their assessment of it was very favorable. They commended primarily its reliable and safe operation as well as good starting with either gasoline or propane-butane. For that reason the test center issued for the system a decision of approval as meeting the provisions of relevant legal measures and recommended its dissemination.

Other advantages offered by the system are its minimum failure rate, smoother engine operation and less wear on the engine, longer service life of its oil, etc. Operation with propane-butane will also be a cause for rejoicing among ecologists, because while the contents of carbon monoxide in exhaust gases of the gasoline engine during idle run turned out to be 3.5 percent and approximately 2.5 percent during driving, these values for propane-butane ranged between 0.5 and 0.3 percent. Excluded is also the possibility of polluting the atmosphere by lead compounds which are used in gasoline as an anti-knock additive. For that reason use of gas for driving motor vehicles is desirable not only in enclosed areas, but also in spas and recreation centers--simply everywhere where we strive to improve the living and working environment.

The VZKG has already a several years' experience with the use of the adapter in vehicles Skoda 1203 and, as shown by analyses, worthy of note is also the comparative fuel cost. The Skoda 1203 negotiates 100 km with Kcs 80 worth of gasoline (and more), the propane butane cost for the same distance: Kcs 20.

The system AP-BV-1 and 2 came into being thanks to the great enthusiasm of the efficiency promotion team in VZKG who worked on it in addition to their tasks. Even though they built it--as they say themselves--actually "from scratch," the adapter for conventional four-stroke ignition combustion engines for propane-butane in gaseous state was tested and approved by the testing institute in Brno.

For the time being things have come to an end. The VZKG plant, due to being oriented toward another production program, cannot market this new system by itself, but no other organs have shown any interest in it either. Drive systems using gas are already in use in the USSR (some taxicabs in Moscow), also in France, Japan, the Netherlands and other countries. The first heralds did also turn up in the CSSR so that we now have at our disposal a domestic system which in its way is better, simpler and cheaper.

8204
CSO: 2402/8

COMPUTER SIMULATION IN HYDROCARBON EXPLORATION

Budapest MAGYAR HIRLAP in Hungarian 27 Nov 81 p 7

[Article by Péter Tromboczky: "Hydrocarbon Exploration--One Billion Yearly"]

[Text] Yesterday afternoon, in Szazhalombatta, Industrial Secretary of State Lászlo Kapolyi inaugurated the 210-million-forint central plant of the Hungarian Hydrocarbon Industry Research and Development Institute.

What would have happened if they had originally altered important decisions? A fiasco could have been avoided. This is, however, hindsight: life's path is unique and unrepeatable. And not only the path of human lives...

And then, before the change caused by the decision takes place--the change takes place. Before the unexpected and irritating loss caused by the mistake irrevocably occurs--the loss occurs, although it may be recovered, if they say: "this way" or "that way," maybe after 15 years. It would be good to know ahead of time. And they find out. It is neither magic nor prophecy but engineering computation: mathematics, and physics, physical chemistry and chemistry, fluid mechanics, geology and rock mechanics, a large number of measurements, laboratory experiments and many other things.

It Would Be Good To See

In order to make the picture--still confused--clearer, we must know a few things. For example, we must know that only a certain portion of the oil hiding in the pores and tiny clefts of rock can be produced. The size of this portion, however, depends on a number of factors--among other things, on the density of wells located on the oil deposits and their output rate. If the suction effect is high, depending on a good many varying physical parameters, to a lesser or greater degree, gas can enter from the top and water from the bottom; conditions change fundamentally--to put it simply: more oil remains between the wells in the deposits. Of course, it would be possible to use more wells, but a several-thousand-meter-deep well is not cheap. But then we have to produce in more moderate quantities. Thanks to which the total producible oil will increase; but, needless to say, it is not unimportant when it can be produced. To stretch out production is as uneconomical as to force it, ignoring losses. Thus we have to find the solution that is optimal both technically and economically.

Relations are even more complicated than those outlined above; each oil deposit has its own characteristics. At the same time, the deeply located oil deposit cannot be completely discovered, since out of an area of several square kilometers only a few times 10- or a few times 100- square-decimeters is drilled from which geological information can be gained. This information is enhanced only to a certain degree by geophysical and fluid mechanics measurements. And finally, consider Heisenberg's idea according to which: "we cannot make any observations without disturbing the observed phenomenon"; this is valid not only for nuclear physics. It is very true for oil and natural gas deposits, since data can only be obtained by means of this "disturbance," in the course of drilling and production.

And a hydrocarbon deposit (like a human being) has only one life. Still it would be necessary to see ahead: What results from the mode and level of production and from any other intervention, oil forced out by water or gas infusion. It would be beneficial to know the fate of the deposit in several possible versions, to be able to choose the most economical one. This possibility is offered by computerized mathematical simulation, which "plays out" the processes years in advance, in an accelerated manner. Computerized, because the complicated and interdependent changes of parameters can only be traced and predicted this way.

So-called production planning, the development of extrusion methods, is just one branch (although an important one) of the extremely diversified activities of the Hungarian Hydrocarbon Industrial Research and Development Institute. Still perhaps it is worthwhile in this context to mention simulation a bit more in detail to find out at least in one small area how complicated and interdependent even a single research effort is.

Destiny of Assets

The scope of the institute formed on 1 January 1980 is, however, much more extensive. The new base merged together from three institutes practically encompasses the entire spectrum of the oil and natural gas industry; moreover, research extends to the related chemical industry technologies.

The economic importance and weight of these activities is perhaps illustrated by the recently published list of the Club of Hundreds. According to the 1980 production assets, in the ranking of the largest companies in the country, number one is the Danube Oil Industry Company, number two the Nagyalfold Oil and Natural Gas Production Company, and a good many hydrocarbon companies are also members of this club. Thus indicates that the Szazhalombatta Institute can influence the destiny of sizable assets.

Thanks to the new central plant, this institute will be able to function even better than ever before, since the work is performed not in isolated and obsolete barracks, but rather in a civilized workplace, equipped to match the difficulty of the task, in well-equipped laboratories, with the help of a carefully conceived computer center and scientific information base (technical library and 500 periodicals, including 350 Western publications). The regional bases, mostly located near the Alfold and Dunantul companies will, of course, be

maintained--i.e., they will remain "near industry." But even the working conditions of researchers employed in those facilities will improve. Among other things, they will have access to the Szazhalombatta computer center via their intelligent terminals, connected through a telephone line and usable independently.

Use and Benefit

Most of the topics being worked on in the institute are applied research and development; the activity, however, extends beyond the desk and the laboratory. For the sake of resultful practical application, inplant experiments are conducted, and complete technologies are developed, partly independently and partly together with the branch industry. Today I could mention about 25 such larger subject areas, already used in the oil industry. Among them, several have well measurable economical benefits, while others can at best be estimated, since they can only be compared to a still unimplemented and less optimal version. An example of the first group is the branch-industry-level computerized production planning, developed for the process industry, which brings in 5-10 percent extra profit by coordinating transportation, processing and product distribution. But the development of lubricating materials and additives replacing imports has also resulted in substantial savings. The second group is made up by those research topics that, for example, allowed the application of drilling technologies adapted to sp[illegible]ial domestic conditions or production based on the optimal exploitation des[illegible] mentioned at the beginning.

The profit originating from the research and development activities of the institute is estimated at 1 billion forints by the leading experts of the branch industry, and perhaps this number indicates best the significance of the multifaceted and rather specialized activities.

9901
CSO: 2502/27

SOFTING: HUNGARIAN SOFTWARE IN WORLD VANGUARD

Budapest SZAMITASTECHNIKA in Hungarian Sep 81 p 10

[Article by Laszlo Kruppa: "The SOFTING Technology: Hungarian Software in the World Vanguard"]

[Excerpt] In very few places in the world so far do they use a developed software manufacturing technology which gathers into a system and supplements with new products the extensive software tools now available. Such a technology is built on a complex computerized software development system, the latter being--in regard to its functions--a complete analogy of the automated technological line of machines known from industry. If we accept this analogy we can speak of lines of machines which manufacture software, where the line is made up of virtual machines, that is, of operating software elements.

This technology was first used several years ago in the American Department of Defense. The reliability of systems prepared in this way increased to a gigantic extent, not even to speak of the reduction in manufacturing time. Previously, in the development of very large systems (for example, the Apollo Program), they used the refined tools of team work to achieve similar reliability. This required significant over-insurance and the work of very many people.

Manufacturing Lines

It is characteristic of automated software manufacturing or developing systems--as it is of a large technological line of machines--that relatively few people are required to service them while through-put increases to a great extent. Since software manufacture is a rather new branch of industry the software houses of the world are only now beginning to achieve that production volume which requires an "automatic production line" or a complex software development system. But there is no system on the market. At least not yet.

The Essence of SOFTING

After such antecedents the significance of the joint undertaking of the SZAMOK [Computer Technology Training Center] and the SZKI [Computer Technology Coordination Institute] is perhaps more understandable. One team of programmers from each of the two institutes has been working for about a year and a half to create an automated software development system within the framework of the SOFTING project. The matter is very significant from both the professional and business viewpoint because such

a system has not yet been used in the "civilian sphere." The name of the software development apparatus, SOFTING, is a witty abbreviation reminiscent of a new English word which refers to software manufacture.

The diagram shows the structure of the combined system made up of a number of components. The several subsystems carry out different functions and are linked to one another like links in a chain. We should understand the latter to mean that the input information for each subsequent subsystem is based on the data processed by the preceding subsystem.

We can take the block diagram which can be seen in the SOFTING diagram as the general technological course of software manufacture. Let us look at it step by step:

1. The problem which is to be solved is defined on the basis of the system plan (rendszerterv).

2. With the aid of the SOFTSPEC system we give the specifications of the system to be developed, or we check these specifications.

3. SOFTCON performs program design and evaluation.

4. SOFTGEN is program generation.

5. We receive the solution (megoldas) in the form of programs in the IBM Assembler, COBOL or PL/I languages.

6. SOFTDOC provides automatic program documentation and static analysis.

7. SOFTTEST provides dynamic program testing.

8. SOFTINT provides system testing and integration.

9. The finished software can be used to solve the initial problem.

Cooperation

The man with the idea, and the professional leader of the group made up of the SZAMOK and SZKI teams, is Harry Sneed, an energetic American. As founder of the FRG firm called SES GmbH he also undertook a large part of the financing of the business. So the SOFTING project is being realized in a three-way cooperation. The profit will be divided among the three participants, the SZAMOK, the SZKI and the SES GmbH and the "invisible" partner, Metrimpex, which takes care of the foreign trade deals. By means of good professional and business tactics the two programming teams succeeded in dividing up the work between them so that while the SOFTING subsystems relate to one another the individual components being gradually prepared can be marketed separately also. It is thanks to this that a number of the SOFTING components to be completed first and which have been accompanied by international interest (FRG, Sweden, etc.) have been sold or leased out already.

The selling price of the subsystem is 25,000 West German marks. For the time being the market situation is such that it is not possible to satisfy every potential customer because the members of the team, primarily burdened with development, do not have enough time for the installation which is obligatory at the time of sale.

According to the business policy which they hope to realize the SOFTING project should be profitable even in the developmental phase.

We have not yet spoken of the time factor, which has a crucial effect on the success of the project. It is nevertheless obvious that in order to pluck the moral and material "laurels" offered by the market situation the Hungarian enterprises, which have only sparse western references, must appear with their product before the others. And these "others" are not resting. (Certain Japanese colleagues, for example, have already largely developed their competing system. The leader there also is an American.) So there is a race which it would be good to win.

A Few Professional Details

SOFTDOC, the first subsystem to be completed, is written in PL/I and can be run under IBM DOS/VS, OS/VS or MVS operating systems. SOFTDOC performs automatic analysis and documentation of already prepared software products. With its aid one can review those program systems which, because of their size and complexity, cannot be operated well--or cannot be operated at all--the correction of which is virtually impossible. And this is a very frequent phenomenon.

The name of the next component to be finished, by the SZAMOK alone, is SOFTTEST. This subsystem, performing dynamic testing of programs, will be larger and more expensive than SOFTDOC. Although it is not yet finished there are already customers for it. The installation of SOFTDOC is now under way at the Bertelsmann firm in the FRG so that SOFTTEST, which will be ready in the near future, can be put into operation without delay. (The running of SOFTDOC is a precondition for the operation of SOFTTEST.)

The SZKI team is now working on the development of the SOFTSPEC component.

8984
CSO: 2502/30

NEW FLUID RECOVERY PROCESS ACCELERATING DRILLING OPERATION

Bucharest REVISTA ECONOMICA in Romanian No 48, 27 Nov 81 p 6

[Article by Horatiu Seiceanu, Minister of Petroleum]

[Text] An increase in the production of oil, and of hydrocarbons in general, is a priority requirement for assuring the fuel needs of the economy and meeting the demand of the chemical industry. An analysis of the activity carried out during the first ten months of the year, shows that the results obtained so far have been below planned levels. One important factor among the many contributing to this situation, is the drilling activity: the program for starting new productive wells has not been completed on schedule because of shortcomings in this activity. At the same time, extraction trusts have also failed to perform a satisfactory activity, a fact which has had negative repercussions on the fulfillment of plan provisions.

As has been pointed out in the most recent party documents, it is the duty of all responsible factors, beginning with drilling enterprises, extraction derricks, and trusts, and ending with the ministry, to concentrate their efforts so as to eliminate existing shortcomings and create all the conditions which will allow the recovery of delays, and the complete fulfillment of plan tasks.

Under these conditions, particular attention is being devoted to drilling activities, and especially to very deep drilling, in order to exploit new hydrocarbon reserves. Because high temperatures and pressures are encountered as depth increases, drilling activities have raised--and still raise--special problems in developing appropriate work techniques. Because of this, drilling fluids are very significant in proper well formation.

Until recently, the fluids used for well drilling were stored in pits dug into the ground, which were generally abandoned once the wells were placed in operation; this created problems in returning the land to agricultural use. What is more, a number of expensive substances, such as barite, remained in the abandoned fluids. These considerations imposed a reorientation in the design of surface equipment available at installations, as well as in the possibilities for efficient reutilization of the drilling fluids left behind after well completion. It became a matter of building systems which would allow the centralized collection of surplus fluids from wells, their transportation in special installations for eventual treatment to restore their properties, and their reutilization in other wells. By means of this cycle, very good revalorification results are obtained for some components, with great reductions in specific consumptions.

Time spent on:	1980	1981 (9 months)
Bottom drilling (%)	26.2	29.6
Bottom drilling (hours)	81,925	99,340
Controlling fluid losses (%)	1.2	0.78
Auxilliary work and fluid preparation at the well (%)	21.3	20.7

The interest of researchers in this domain was finalized in the design and construction of nine central fluid stations equipped with mechanized devices for preparing, cleaning, and treating drilling fluids, and with capabilities for storing them according to type. The most efficient solutions were analyzed as part of these standardization projects, concluding that the construction of stations in 500 cubic-meter modules is appropriate for field conditions, allowing the optimization of capabilities or of lines for preparing special fluids, to meet the dynamics of drilling activities. A special contribution in the recovery and reutilization of drilling fluids has been made by the Automatica enterprise of Medias, through the construction of the special tanker truck CFF-1, with a capacity of 10 cubic meters and a useful load of 16 tons. The endowment of drilling derricks with 120 special tankers of this type has increased the volume of recovered fluids to 61,600 cubic meters in 1980, and during the first nine months of 1981, the placement in operation of new central stations has brought the volume of recovered and reutilized fluids to 44,000 cubic meters.

The first effect of this action has been to reduce the consumption of barite--about one-half of which is imported--by 9000 tons in 1980; it is expected that the total volume of barite reutilized through recovery will exceed 9500 tons in 1981. The savings achieved during the first nine months of the year (about 7800 tons of barite) amount to approximately 12 million lei.

Since the integration of central stations for fluids into well drilling activities, improvements in the quality of fluids have also improved drilling indicators for those trusts that are endowed with such stations. At the Moinesti Oil Trust for instance, an efficiency higher than that of last year was noted during the first three quarters of 1981, resulting directly from the action of drilling fluids in technologic processes (see table). Some other similar results of this activity are: it eliminated the digging of storage pits at 45 wells in Moinesti alone, which amounts to about 2 hectares of agricultural land; reduced the transportation of chemicals to wells being drilled; achieved fuel and energy savings by abandoning the use of 800-1250 hp pumps at stations for the preparation of drilling fluids; returned immediately to agricultural use, the land temporarily assigned to wells, and avoided environmental pollution; and it provided an additional 8000 hours allocated to drilling, resulting in an additional 16,000 meters drilled with the same equipment and personnel, which in only five months would represent an additional 105,000 meters drilled nationwide.

The utilization possibilities of central stations for fluids are far from exhausted. Recent research at the Institute for Petroleum and Gas Research and Design, in Cimpina, has disclosed that as a result of chemical treatments performed at wells, the marls traversed by the drill and transformed into drilling fluid through the addition of water, become activated with a yield of more than 12 cubic meters of

fluid per ton. The transformation of these fluids into powders through atomization, would represent a source of raw materials for the oil extraction industry, for waterway improvements, for use in foundries, and so on. At the same time, the atomization of heavy fluids with high barite contents, would not only allow easy storage of their constituent solid substances, but would also make it possible to instantly prepare fluids with a desired specific gravity, simply by disolving these substances in water and reusing them in wells which require greater amounts of fluids. However, this operation also involves some energy consumption, which according to laboratory experiments amounts to 200 N cubic meters of gases per ton of powder created by atomizing drilling fluids. Despite this, the process deserves a more detailed analysis, seeking the most economical solutions from an energy standpoint, such as the use solar energy for preheating, and so on, since the effects of the process' application would ultimately lead to substantial savings through fluid recycling.

Given the advantages that can be derived from the construction of central stations for fluids, it can be seen that their standardization in modules creates the basis for integrating all drilling activities into one system, so that the action could be completed during the current five-year plan. This is facilitated by the fact that the equipment of central station modules can be fabricated entirely in our country by units of the Ministry of Petroleum (tanks, stirrers) and the Ministry of the Machine Construction Industry (centrifugal pumps, metal fittings, valves, and so on). At the same time, greater concern is required on the part of trusts, to act more firmly in this direction; as well as on the part of land and territorial organization offices in county people's councils--especially in the counties of Arges and Timis--to more efficiently complete approval formalities for land utilization.

The combination of the positive effects mentioned here argues in favor of building and using central stations for fluids as rapidly as possible, so that this new and efficient system with ultimate positive effects on higher oil production, will be extended throughout all drilling activities.

11,023
CSO: 2702/2

UDC 621.31(497.1)

DETAILS OF 1980 POWER BLACKOUT, PREVENTIVE MEASURES VIEWED

Ljubljana ELEKTROTEHNICKI VJESNIK in Serbo-Croatian No 1, 1981 (manuscript received 29 Jan 81) pp 1-7

[Article by Dr Marjan Plaper, graduate engineer and professor at the School of Electrical Engineering of Ljubljana University: "Disturbances in the Operation of Yugoslavia's Electric Power System"]

[Text] 1. Introduction

All present-day electric power systems are susceptible to damage to some extent. An electric power system which would guarantee 100-percent reliability of supply to consumers would be outsized and extremely expensive. That is why in every system today there is some probability of operating disturbances. The seemingly harmless failure of just one element in the system can sometimes cause the successive failure of key facilities and a partial breakdown of the system with serious socioeconomic consequences.

Let us merely recall the disastrous power "blackout" on 9 November 1965 in the eastern United States (Consolidated Edison Company of New York), when 30 million customers were affected and when it took 13.5 hours to put the system back in order. There have been less severe disturbances in the same area in 1971, 1972, 1973, 1974, 1976 and on 13 July 1977 there was again a sizable breakdown affecting 2,725,000 customers; since it took all of 25 hours to put the system completely back in order, the socioeconomic consequences were even greater than those in 1965.

A power blackout affected virtually all of France on 19 December 1978, and soon thereafter Vienna and after that Sweden as well. The damage in France was estimated at the time between 3 and 4 billion francs, which today would represent between 20 and 25 billion dinars. The situation in which the breakdown of the French electric power system occurred in 1978 was similar to the situation on 8 December 1980 in Yugoslavia, when at 1605 hours a power blackout affected several of our republics and provinces. There was the difference that supposedly an improper rate policy at that time encouraged the French to make exaggerated use of electric power for residential heating, while in our case there was excessive consumption of electric power because of the general energy crisis which has already affected the entire civilized world.

2. Characteristics of the Yugoslav Electric Power System

A relatively large growth of electric power consumption was recorded in 1980 (9.6 percent, while the average over the last 10 years is 8.8 percent) because of the noticeable conversion of consumers to electric residential heating in the wintertime and also the relatively augmented consumption of what are referred to as direct (large) customers. During cold spells consumption increased even more than 20 percent over the same period in 1979.

At the end of 1980 the Yugoslav electric power system had 224 generating units in hydroplants, thermal electric power plants and heating plants, distributed as follows:

i. 70 units in thermal electric plants with a total installed capacity of 7,098 megawatts, or 54.2 percent of total capacity (42.2 percent fired by coal, 9 percent by oil and 3 percent by gas);

ii. 154 units in hydroplants with a total installed capacity of 5,995 megawatts, or 45.8 percent of total capacity (19.7 percent run-of-river, 22.9 percent storage and 3.2 percent reversible).

Hydrological conditions were highly favorable in 1980. The occasional shortage of coal at certain steam plants (Kosovo, for example) and oil-fired plants did not have severe consequences (gas-fired plants were put on line in exceptional cases to handle peak loads).

We should mention that normal operation of an electric power system requires a certain reserve of sources of energy in storage reservoirs, stocks of coal and oil at steam plants, a "cold" reserve of standby steam plants to cover major equipment breakdowns (about 10 percent of installed capacity of steam plants) as well as "hot" backup capacity to cover sudden failures (about 5 percent of the capacity on line). The electric power industries of Yugoslavia's republics and provinces by and large provided the "hot" standby capacity in 1980 necessary to cover failure of plants and transmission facilities, and they came to each other's aid in case of failures. This ensured the necessary reliability in operation of the system except at peak loads in the system. Linkage and parallel operation with the West European electric power interconnection of UCPTE contributed greatly to increasing the stability of the system's operation [1]. Figure 1 shows how the demand was met in average operating days on a month-by-month basis in 1980. One can conclude from this that there was a net balance in terms of power and foreign exchange with foreign countries in that year even if we ignore the other constructive consequences of the linkage involved.

The Yugoslav electric power system consists of eight (in December 1980 it was still six) self-managing republic and provincial subsystems. Each electric power industry is responsible for the development and construction of electric power facilities and for supplying electric power to customers in its area. The electric power industries of these subsystems guarantee the technological integrity of the entire Yugoslav electric power system within the framework of the Community of the Yugoslav Electric Power Industry (JUGEL). Load control centers in the republics and provinces are responsible for monitoring, regulating and

operating electric power facilities, while the federal load control service is responsible for coordinating the operation of the republic and provincial centers in the sense of ensuring the technological integrity of the Yugoslav electric power system and for cooperation with the systems of neighboring countries.

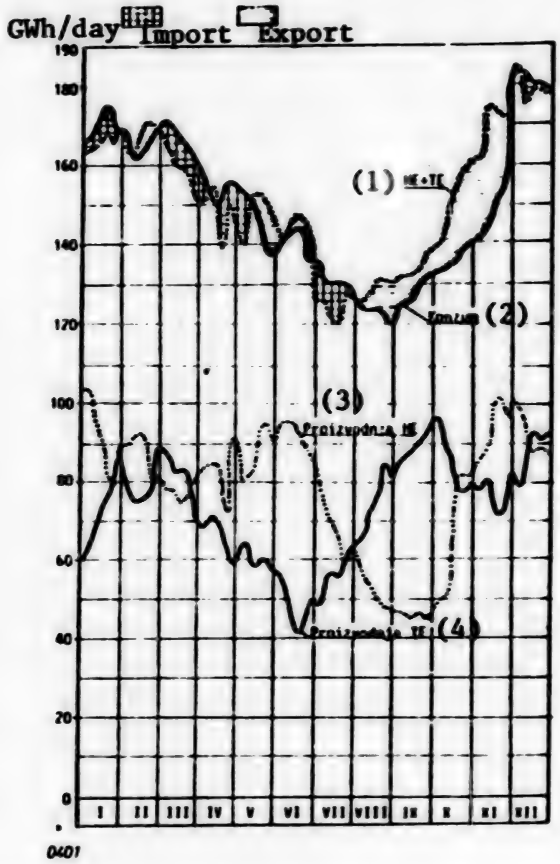

Figure 1. Meeting the Yugoslav demand for power from power plants on average operating days in 1980.

Key: 1. Hydro and steam plants
2. Demand
3. Output of hydroplants
4. Output of steam plants

3. Technical Causes of the Breakdown in the Yugoslav Electric Power System on 8 December 1980 at 1605 Hours

It is evident from the report of the JUGEL load control service that there were several disturbances in operation of the Yugoslav electric power system in 1979 and 1980: 6 in 1979 and 11 in 1980 with sizable consequences. By contrast with 8 December 1980, all the other disturbances were on a smaller scale and more brief, and they went all but unnoticed in the daily diagrams of electric power consumption. The main reason for this was the rapid intervention of the West European interconnection of UCPTE.

It is evident from the daily diagram of electric power consumption on 8 December 1980, given in Figure 2, that the disturbance on that day had quite serious consequences.

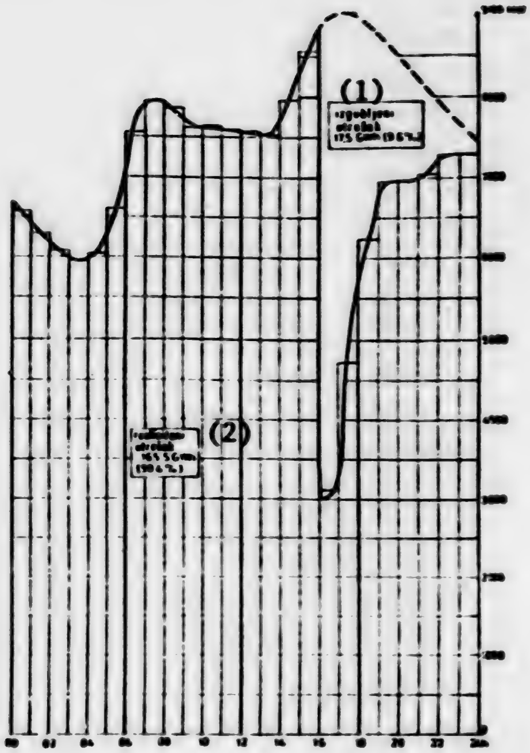

Figure 2. Daily diagram of Yugoslavia's consumption on 8 December 1980.

Key: 1. Lost load ... 2. Load handled ...

On that day there was a loss of 9.6 percent of the day's power, or approximately 17.5 million kilowatt-hours, and if we put a value of $1 (29.5 dinars) on every kilowatt-hour, the loss incurred by our economy was half a billion dinars (new dinars, of course!). It is evident from the daily diagram for Slovenia on that day that that subsystem failed in its entirety at 1605 hours and more than 4 hours passed before it was fully restored.

If we examine the diagram of Yugoslavia's 400- and 220-kv transmission networks on 8 December 1980, given in Figure 4, and compare it with Phase I of the basic 400-kv network in Figure 1, taken from [1], we see that in December 1980 the 400-kv link Trebinje--Titograd--Ravna Rijeka--Kosovo was not in service (the transmission lines had been built, but the substations had not), though as early as October 1978 it had been officially declared that this phase in construction of the network had been concluded. Aside from that, back on 5 and 6 November 1980 there had been extremely serious breakdowns because of disastrous icing (freezing rain!) in Dalmatia, Lika, the Rijeka area and western Slovenia. The most serious damage was on the Brinje--Kojsko (both), Meline--Brinje, Divaca--Meline and Divaca--Pehlin transmission lines. Consequently, in December 1980 practically the entire southern section of the Nikola Tesla 400-kv network from Ljubljana and all the way to Kosovo was out of service, and it certainly would have prevented the disaster in the Yugoslav system at 1605 hours on 8 December 1980.

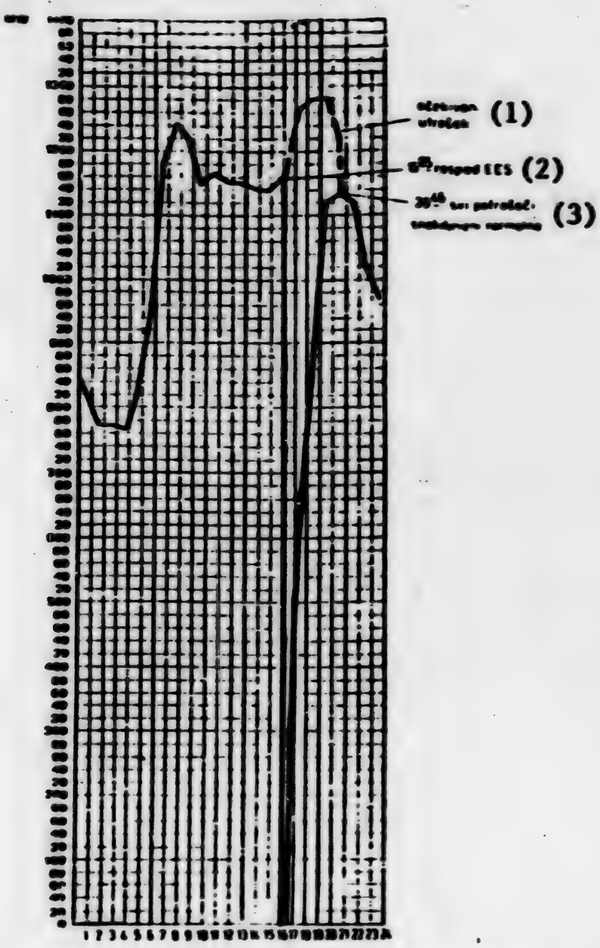

Figure 3. Daily diagram of Slovenia's consumption on 8 December 1980.

Key: 1. Expected load
2. Breakdown of Slovenian electric power system at 1605
3. All customers supplied normally at 2046

A special commission of experts at JUGEL* in Belgrade to investigate the causes of the blackout gathered data on power flows in megawatts on the interrepublic and international transmission lines 5 minutes before the breakdown (at 1600 hours). These figures are given along with the net power balances in the 220- and 400-kv networks by republics in Figure 5. The contribution of the Albanian Mao Tse Tung Hydroplant (directed operation!), intended partly for Macedonia and partly for Slovenia, is indicated as Montenegrin output. The Yugoslav electric power system was operating, as in any case it does, in parallel with the Greek system and the connected system UCPTE 1.

It is evident from Figure 5 that Slovenia, Croatia, Serbia with the autonomous provinces, and Macedonia showed a deficit, while Bosnia-Hercegovina and Montenegro were republics with a surplus. If we draw up a diagram showing Yugoslavia's deficit and surplus areas, the result is Figure 6, which shows that the deficit

* The author of the article was a member of that commission (editor's note).

in Slovenia, Croatia, Serbia and Macedonia on that day total 1,491 megawatts at 1600 hours, which was covered with 10,031 megawatts from the surplus republics of Bosnia-Hercegovina and Montenegro, while 395 megawatts came from UCPTE and 65 megawatts from Greece.

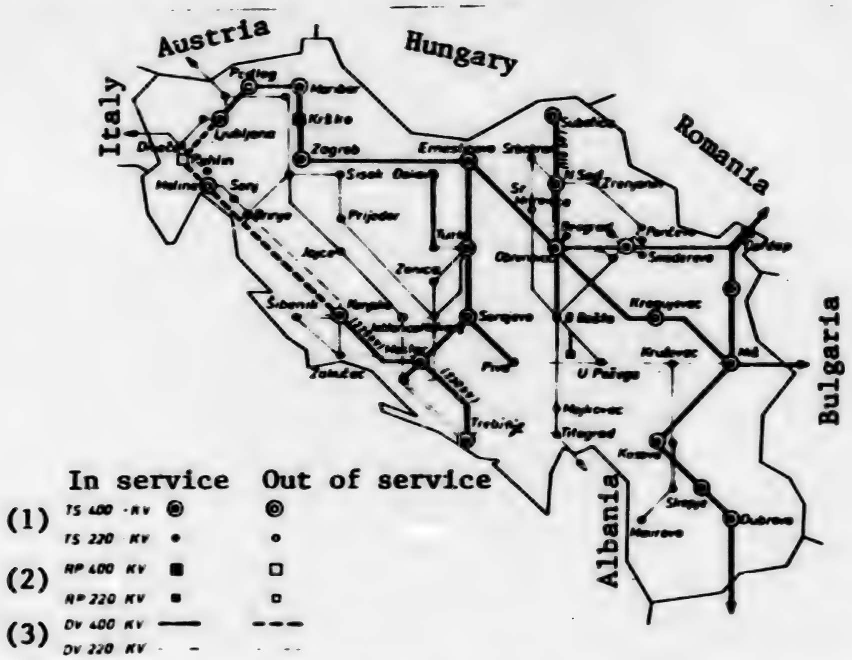

Figure 4. State of Yugoslavia's 400- and 220-kv transmission networks on 8 December 1980.

Key: 1. Substation
2. Circuit-breaker station
3. Long-distance transmission line

In the emergency situation the interrepublic 220-kv long-distance transmission lines between Tuzla and Djakovo were unable to help because of Djakovo's radial feed, nor could the Mostar--Zakucac and Mostar--Konjsko links because transmission lines to the areas with a shortage were either down or out of service, as has been specifically indicated in Figure 6. Only the Tuzla--Ernestinovo 400-kv and Piva--Uzicka Pozega and Titograd--Bajina Basta 220-kv interrepublic links, all of which had a high load, and the Jajce--Mraclin and Prijedor--Sisak 220-kv transmission lines, with a smaller load, were able to help. Only 22 percent of capacity was directed westward from the center of Yugoslavia. The rest received about 400 megawatts from UCPTE, thereby covering 100 percent of Slovenia's deficit and 43 percent of Croatia's deficit. All of 78 percent of the capacity in the center of Yugoslavia was directed eastward. On 7 and 8 December four large generating units and one boiler with a total capacity of 978 megawatts (9.5 percent of the total employed capacity of all power plants in Yugoslavia) went out of service in the subsystem consisting of Serbia and the autonomous provinces. The shortage of power was covered from the "hot" standby capacity of the entire Yugoslav system and with unscheduled imports from neighboring countries. Certainly the needed power had to flow into Serbia from quite distant areas, which put an appreciable load on certain long-distance transmission lines, and because

of the simultaneous shortage of "sterile" power greatly reduced voltages in the area of Serbia where the shortage was.

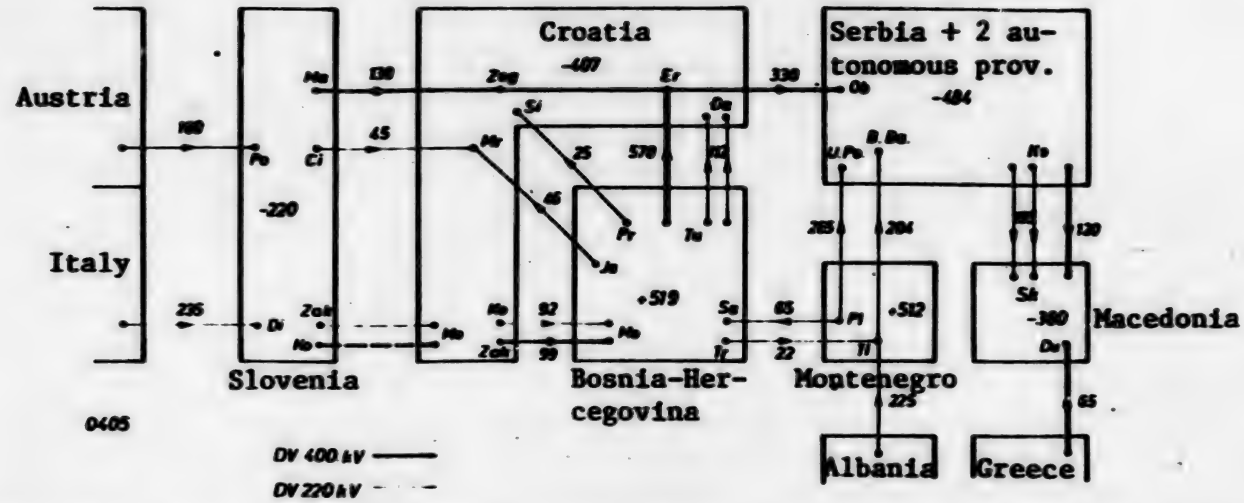

Figure 5. Power flows on interrepublic and international 400- and 220-kv long-distance transmission lines with republic power balances in megawatts at 1600 hours on 8 December 1980.

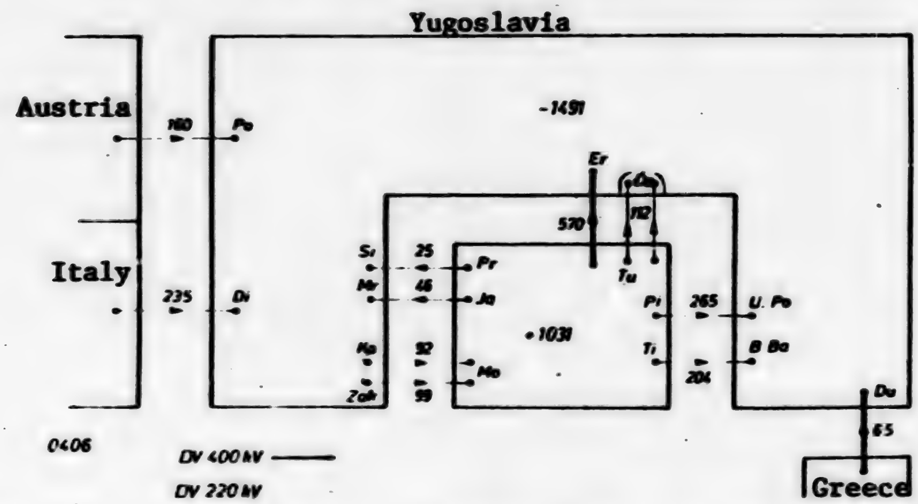

Figure 6. Flows of power (in megawatts) between areas with a surplus and areas with a deficit in Yugoslavia at 1600 hours on 8 December 1980.

At 1602 hours on 8 December 1980 the breakdown began with failure of the overloaded 220-kv Piva--Uzicka Pozega transmission line (overcurrent protection was in operation). Since under these conditions the power must seek longer routes to the areas with the shortage, total transmission impedance jumped suddenly to a higher value, and we can elucidate the phenomenon qualitatively by means of the "equal areas" criterion in the well-known theory of stability. We can compare the model in Figure 6 in part to the model in Figure 7a, where the power flow P between the area with the surplus 1 and the area with the shortage 2 over the equivalent transmission reactance X is:

$$P = (U_1 U_2 / X) \sin \theta$$

in which θ is the angle between the voltages U_1 and U_2 at the connection between areas 1 and 2. It is clear that this picture is highly simplified and allows only a qualitative analysis of relatively complicated phenomena.

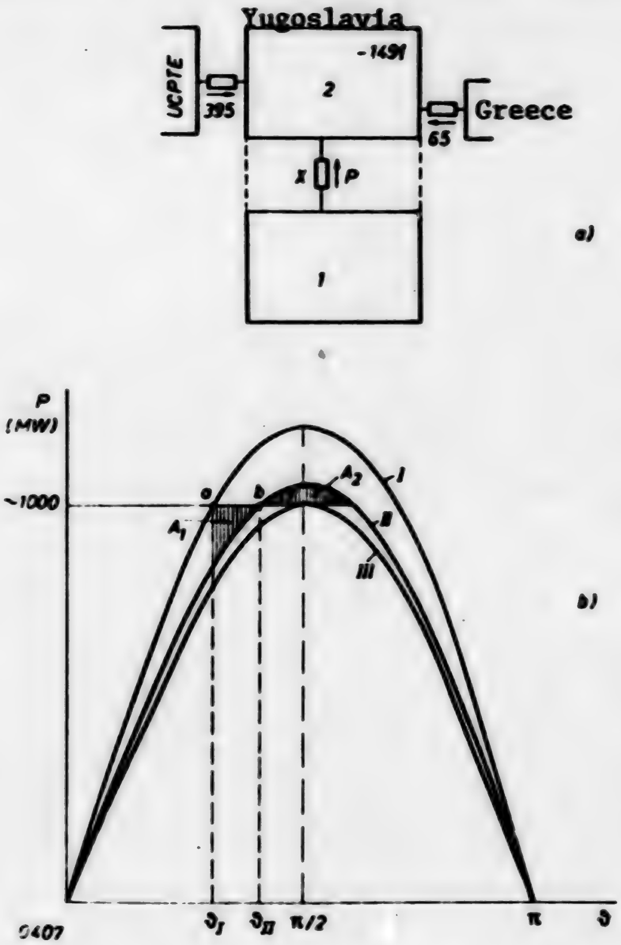

Figure 7. a) Simplified model for interpretation of the events in the Yugoslav power system at 1605 hours on 8 December 1980; b) illustration of the events by the conventional criterion of "equal areas."

In Figure 7b the operating point in the initial stage of equilibrium on the sine curve I determines the angle of stability between areas 1 and 2 θ_1. When the Piva--Uzicka Pozega connection failed, the total transmission reactance X between areas 1 and 2 suddenly increased, the voltage U_2 at the heart of the region with the shortage dropped (because of the low voltage U_2 the amplitude of the curve I for transmission of 1,000 megawatts was relatively low!). That greatly reduced the amplitude of the sinusoid (curve II in Figure 7b). That caused a power fluctuation on the order of 1,000 megawatts around the new operating point b on curve II, which shook the entire Yugoslav electric power system. When the highly loaded 220-kv Piva--Uzicka Pozega link failed, a new state of equilibrium had to be stabilized at point b on curve II, that is, a higher angle of stability attained between the two areas.

Probably even at that time there was a surplus of kinetic energy of rotating masses in area 1 (acceleration) equal to or even greater than the shortage of electric power in area 2 (deceleration), that is, the area of acceleration A_1 in Figure 7b was equal to or even greater than the area of deceleration A_2 and thereby threatened stable operation or even made it impossible. The possibility of stable operation was diminished still more by the failure of the highly loaded 220-kv Titograd--Bajina Basta long-distance transmission line. The additional increase of X and additional drop of U_2 diminished even more the amplitude of the sine curve, and probably the stable operating point for transmitting 1,000 megawatts of power vanished altogether (curve III in Figure 7b).

The 220-kv links with UCPTE, which are weak and highly loaded for present operating conditions (the Divaca--Padrice ring of SUDEL was loaded with a flow of 235 megawatts in the direction of Yugoslavia!) deteriorated even more the critical situation, since they were unable to withstand the stability fluctuations.

Following the successive failures of the highly loaded Piva--Uzicka Pozega and Titograd--Bajina Basta 220-kv links, the separation of the Yugoslav system from the UCPTE interconnection and Greece (with a shock shortage in Yugoslavia of approximately 500 megawatts), the rapid drop of frequency and the successive failures of power plants in the areas of our country with a shortage were a logical consequence of the convulsive and unsuccessful search for a new state of equilibrium for a power flow of about 1,000 megawatts between the areas of Yugoslavia with a surplus to those with a shortage. Within the country it was no longer possible to attain that state with the connections that still existed. It is also clear that the subsystems with a surplus, Bosnia-Hercegovina and Montenegro with Dalmatia and a part of Slavonia, stayed in operation after a brief rise of frequency.

4. Certain Measures for Safer Operation of the Yugoslav Electric Power System

It is stated in an article listed as [1] that back on 1 August 1971 an agreement was signed in Yugoslavia among the relevant enterprises concerning the foundations of parallel operation of domestic and foreign systems. The Yugoslav electric power system, taken as a technological unit, was not at that time so clearly divided into republic and provincial subsystems as it is today, which accounts for the omission of many provisions concerning parallel operation which we find in the new self-management accord prepared in November 1980 [2], and which had not been signed even in late December 1980.

The new self-management accord [2] (the provisions of the 1971 agreement remain in effect until the signing) regulates mutual reconciliation of electric power budgets, the assurance and use of the total reserve capacity in Yugoslav power plants, the coordination of weekly and daily operating plans of power plants and transmission connections, the transit of electric power, exports, imports and exchange of electric power with foreign countries, secondary regulation of the electric power system, coordination of operational management of the 400- and 220-kv transmission networks, coordination of projects related to development and maintenance of the technical system for load control, mutual adjustment of parameters of electric protection and characteristics of turbine regulators. It also contains provisions on the committee for joint operation and the load control service of the Community of the Yugoslav Electric Power Industry.

The 1971 agreement precisely defined secondary network regulation, but had absolutely nothing to say about primary regulation. But secondary regulation can in no way take the place of primary regulation. It is evident from the study listed as [3] that primary and secondary regulation must complement one another, since both methods of regulation have a limited capability. Primary (turbine) regulation, which automatically and on a regional basis forces the generating unit to deliver greater power when there is a drop in frequency, has essential importance in emergency situations in the parallel operation of large systems. A majority of the units in Yugoslavia operated in the past with turbine regulation "blocked." In the UCPTE countries today they regard that mode of operation as a poor and dangerous habit. They say: operate power plants according to schedule (with constant load) yes, but by no means without statics. After the poor experiences in large systems, the terms "statics" and "self-regulating factor of the system" are again at the center of attention. Attention has increased especially with the introduction of the larger thermal units, which has not been cooperating in primary regulation, so that the regulating characteristics of electric power systems have deteriorated greatly. The rule in the UCPTE interconnection is that all power plants are to collaborate in primary regulation. Every plant which in a critical situation is not cooperating with the appropriate statics (they speak of 4 to 6 percent) is at the very least contributing to the system's failure. The statics of the machines is also a precondition for attainment of a usable self-regulating factor of the system (and the statics of the system), which we can attain only when all the machines cooperate. Only under such conditions is it possible to achieve a smaller drop of frequency in emergency situations until the slower secondary regulation reacts and normalizes the frequencies.

It has been established by experiments for 1971 that the self-regulating factor of the Yugoslav electric power system is approximately 300 MW%Hz. This factor has risen somewhat in subsequent years, but it is certainly too low in view of the growth of the power of the Yugoslav system. Because the contribution of our primary regulation is too small, that is, because the respiration of the Yugoslav electric power system by means of primary regulation is too weak, sudden imbalances between load and production are imparted too rigidly to the international connections and cause situations threatening partial or complete breakdown of our electric power system.

Normally the transmission lines making the link with the UCPTE interconnection ought not to be fully employed in importing electric power into Yugoslavia. This means that the simple capacities of those transmission lines ought to be so great that they can take over the failure of the largest unit in Yugoslavia without threatening interruption of connections with the UCPTE interconnection. Since at present the largest unit in Yugoslavia is operating at Sostanj and has a threshold capacity of 294 megawatts, the most we should be importing from Austria and Italy is a total of about 60 megawatts. According to international recommendations [3], the total effect of these links, taking the capacity of the Yugoslav system at 10,000 megawatts, should be at least 500 megawatts for parallel operation to be advisable at all. The effect of the existing 220-kv SUDEL ring [7] barely reaches 350 megawatts and until the Divaca--Redipuglia 400-kv link goes into service, it is the most pronounced bottleneck in parallel operation of the Yugoslav electric power system with the UCPTE interconnection.

The commission of experts of the Community of the Yugoslav Electric Power Industry learned among other things that system protection in Yugoslavia on 8 December at 1605 hours was not functioning properly and that only in Croatia and Bosnia-Hercegovina was the value at which the underfrequency relays tripped in conformity with the provisions of the self-management accord, while in all the other republics and autonomous provinces the value at which the circuit breakers opened was far below the agreed level. The reliability of undercurrent protection during disturbances is in any case highly problematical and it would be good to think about more effective capabilities for taking the load off electric power systems (even at nominal frequency) [4].

5. A Look Into the Future

Though over the past 5 years (1976-1980) power plants with a capacity of about 5,000 megawatts have been built in Yugoslavia, the gap has not yet been closed between the growth of production and the growth of consumption of electric power, which has been growing faster than the growth of new plant capacities. The world energy crisis and problems that have arisen in our country in connection with the increasingly difficult conditions for obtaining a supply of petroleum and gas threaten in future a still wider gap between the production and consumption of electric power and a still greater probability of disturbances in our electric power system.

In future we face large tasks in the area of more intensive development of domestic sources of energy and their more optimum utilization, especially because of the need to replace imported energy as much as possible by domestic energy. Faster use will have to be made of the hydroelectric potential (only 40 percent of it has so far been utilized in Yugoslavia!). Steam plants with large units at lignite mines will have to be built more rapidly, especially at the sites already designated, nor is the exploitation of nuclear power in last place, and business people in the world are still predicting it will have a great future in generating electric power in spite of the opposition of ecologists [5].

Today there is a great deal said about various alternatives whereby humanity would solve problems connected with energy. But in this area there are still too many people with a euphoric outlook, while in realistic terms there are not so many optimistic explorations; too little consideration is given to the inevitable patterns in the technological development of energy processes. In general we distinguish five phases in the technological development of energy processes:

1. The process has not been scientifically studied. This is the case, for example, with the use of nuclear energy by the process of controlled fusion.

2. The process has been studied scientifically only in the laboratory. This is the case, for example, with the process of direct conversion of solar energy to electric power.

3. The process has been studied at the engineering level on small-scale prototypes and has not yet been put into industrial production. An example of this would be conversion of coal to gas.

4. The process has been studied at the industrial level with equipment of the size envisaged, but they still are not economically profitable. This is the case, for example, with nuclear breeder reactors.

5. The process has been studied even at the economic level with efficient equipment: fossil fuel steam plants, power plants with light-water nuclear reactors, hydroplants, and so on.

The transition from one phase to the other toward the fifth phase, which is the target, is usually a rather difficult and prolonged one and depends greatly on the intensity of relevant research. Realistic energy experts in the world expect very little from unconventional sources of energy (the sun, wind, the tides, geothermal energy, and so on) as sources of electric power in the first decades of the next century [5]. In an international conference in Milan in April on alternative energy sources to solve the energy problems of Europe as a whole three factors were primarily mentioned as solutions: nuclear power, mutual linkage of electric power systems and accumulation of energy with reversible power plants [6]. These factors should also facilitate easier inclusion of those sources of energy which are incidentally highly variable and cannot be accurately predicted, such as direct use of solar energy. Because of the shortages which threaten in the energy supply, these factors ought at the same time to be the principal measures used to attain minimum vulnerability of European electric power systems. At the same time there must certainly not be any neglect of every measure toward energy conservation and toward maximum efficiency in the use of existing sources of energy.

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